PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-161124

(43)Date of publication of application : 13.06.2000

(51)Int.CI. F02D 45/00
F01L 3/24
F02D 13/02

(21)Application number : 10-334298

(22)Date of filing : 25.11.1998

(71)Applicant : NISSAN MOTOR CO LTD

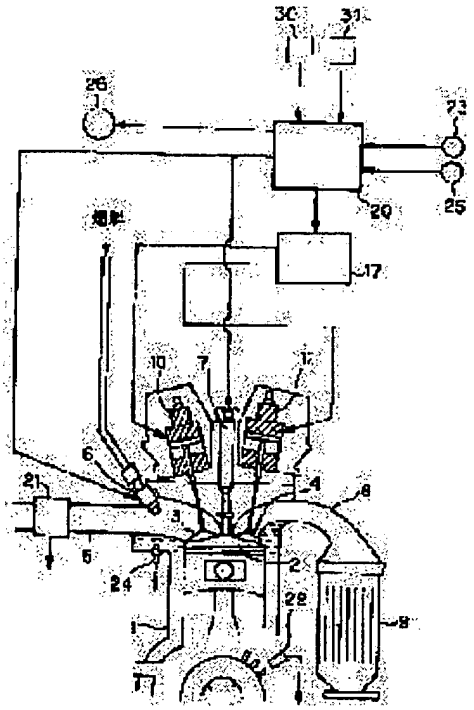
(72)Inventor : MATSUMOTO MIKIO
NAGAISHI HATSUO
HIRASAWA TAKAHIKO

(54) FAILURE DETECTING DEVICE FOR VARIABLE VALVE SYSTEM ENGINE

(57)Abstract:

PROBLEM TO BE SOLVED: To exactly detect a failure of an intake air amount sensor for a variable valve system engine provided with intake- and exhaust valves.

SOLUTION: This engine is provided with intake and exhaust valves 3, 4 to control the intake air amount and the discharge of exhaust gas of a cylinder by the opening and closing timings of these valves, and is provided with an intake air amount sensor 21 for measuring the intake air amount in an intake passage 5. In this case, an intake air amount estimating means for estimating the actual intake air amount based on the cylinder inside volume when at least the intake valve 3 is closed, a means for comparing the estimated value to the measured value of the intake air amount sensor 21, and a failure judging means for judging a failure in the intake air amount sensor 21 based on the comparison result, are provided.



LEGAL STATUS

[Date of request for examination] 26.12.2001

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

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CLAIMS

[Claim(s)]
[Claim 1] The good change valve engine which equips an inhalation-of-air path with the amount sensor of inhalation of air which measures an inhalation air content while it has ** and the exhaust valve which are characterized by providing the following and the inhalation air content and exhaust outlet of a cylinder are controlled by the opening-and-closing stage of these valves An inhalation air-content presumption means to presume an actual inhalation air content based on the cylinder content volume of the closed stage of an inlet valve at least A comparison means to compare this estimate with the measurement value of the amount sensor of inhalation of air A failure judging means to perform the failure judging of the amount sensor of inhalation of air based on this comparison result
[Claim 2] The aforementioned inhalation air-content presumption means is good change valve engine-malfunction detection equipment according to claim 1 which has an amendment amendment means for the estimate of an inhalation air content according to the closed stage of an exhaust valve, the open stage of an inlet valve or **, and the amount of overlap of an exhaust valve.
[Claim 3] It is good change valve engine-malfunction detection equipment according to claim 1 in which a throttle valve is prepared in an inlet pipe and the aforementioned inhalation air-content presumption means has an amendment amendment means for the estimate of an inhalation air content according to the opening of the throttle valve.
[Claim 4] The aforementioned amendment means is good change valve engine-malfunction detection equipment given [the estimate of an inhalation air content] in the reduction amendment claim 3, so that the opening of a throttle valve is small and inlet-pipe negative pressure is large.
[Claim 5] The aforementioned failure judging means is good change valve engine-malfunction detection equipment according to claim 1 which judges the amount sensor of inhalation of air to be failure when the difference of the estimate of the inhalation air content of the aforementioned inhalation air-content presumption means and the measurement value of the amount sensor of inhalation of air is larger than the predetermined failure-criteria value defined beforehand.
[Claim 6] Good change valve engine-malfunction detection equipment according to claim 1 set up in the failure criteria by the aforementioned failure judging means for every service condition of the engine which contains an engine speed at least.
[Claim 7] The aforementioned inhalation air-content presumption means is good change valve engine-malfunction detection equipment according to claim 1 which distinguishes ** and the opening-and-closing stage of an exhaust valve from ** and the opening-and-closing control stage of an exhaust valve.
[Claim 8] It is good change valve engine-malfunction detection equipment according to claim 1 which is equipped with the taking-a-seat sensor which detects ** and the opening-and-closing stage of an exhaust valve, and presumes an inhalation air content actual based on the detection value of ** and the opening-and-closing stage of an exhaust valve for the aforementioned inhalation air-content presumption means to be based on a taking-a-seat sensor.
[Claim 9] Good change valve engine-malfunction detection equipment [equipped with the display which displays failure of the amount sensor of inhalation of air] according to claim 1.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] This invention relates to the equipment which detects failure of the amount sensor of inhalation of air which measures especially an inhalation air content about good change valve engine-malfunction detection equipment equipped with ** and an exhaust valve.
[0002]
[Description of the Prior Art] There are some which change ** of an engine and an exhaust valve into a cam action, and are driven with electromagnetic force. This thing can control the inhalation air content and exhaust outlet of a cylinder by valve-opening close timing while being able to set it as the valve-opening close timing which could omit mechanisms, such as a cam shaft, and suited the operational status of an engine (JP,61-247807,A etc.).
[0003] Moreover, there are some which drive ** and an exhaust valve with oil pressure (JP,7-317516,A etc.). This is supplying the oil pressure room formed by the cylinder to which the piston which drives an inlet valve and an exhaust valve, and this piston slide on the oil in which the pressure up's was carried out by the oil pump through the electromagnetic spill valve which performs supply and interception of oil and which was set up for every cylinder, and is controlled for every cylinder at the valve-opening stage of a request of an inlet valve and an exhaust valve, and a valve-closing stage.
[0004] When abnormalities are in this amount sensor of inhalation of air, it becomes impossible to control fuel oil consumption proper in what equips the inhalation-of-air path of the throttle valve upstream with an air flow meter (the amount sensor of inhalation of air), calculates the fundamental injection quantity of fuel from the inhalation air content which the amount sensor of inhalation of air measured, and an engine speed, performs various amendments based on this as the measurement method of the amount of engine inhalation of air in such an engine, and controls the fuel oil consumption of a fuel injection valve, for example.
[0005] What detects the existence of an open circuit of a sensor circuit conventionally as fault detection equipment of such an amount sensor of inhalation of air (JP,10-68647,A), What judges indirectly failure of the amount sensor of inhalation of air from the signal of an oxygen density sensor formed in the exhaust air system, Or there are some (JP,5-001930,A) which judge failure of the amount sensor of inhalation of air from the deflection of the maximum output value of a signal and the minimum output value which are produced by inhalation-of-air throb accompanied by the signal wave form of the amount sensor of inhalation of air, i.e., opening and closing of an inlet valve.
[0006]
[Problem(s) to be Solved by the Invention] However, the abnormalities by gap of the output of the amount sensor of inhalation of air cannot detect what detects the existence of an open circuit of a sensor circuit, and what judges failure of the amount sensor of inhalation of air from the signal of an oxygen density sensor cannot attach distinction with failure of a fuel system easily.
[0007] Moreover, since inhalation-of-air throb changes by the opening-and-closing timing of an inlet valve when controlling the inhalation air content of a cylinder etc. by ** and the exhaust valve rather than the throttle valve prepared in the inhalation-of-air path, it is not necessarily hard to apply what judges failure of the amount sensor of inhalation of air from the deflection of the maximum output value of the amount sensor of inhalation of air, and the minimum output value.
[0008] In the case of the good change valve engine which controls the inhalation air content of a cylinder etc. by ** and opening-and-closing timing of an exhaust valve, this invention aims at offering the fault detection equipment which can detect exactly failure of the amount sensor of inhalation of air by comparison with the estimate and the measurement value of the amount sensor of inhalation of air paying attention to the ability presuming the inhalation air content of a cylinder by the opening-and-closing timing.

[0009]
[Means for Solving the Problem] In the good change valve engine which equips an inhalation-of-air path with the amount sensor of inhalation of air which measures an inhalation air content while the 1st invention is equipped with ** and an exhaust valve and the inhalation air content and exhaust outlet of a cylinder are controlled by the opening-and-closing stage of these valves An inhalation air-content presumption means to presume an actual inhalation air content based on the cylinder content volume of the closed stage of an inlet valve, a comparison means to compare this estimate with the measurement value of the amount sensor of inhalation of air, and a failure judging means to perform the failure judging of the amount sensor of inhalation of air based on this comparison result are established at least.
[0010] In the 1st invention, as for the 2nd invention, the aforementioned inhalation air-content presumption means has an amendment amendment means for the estimate of an inhalation air content according to the closed stage of an exhaust valve, the open stage of an inlet valve or **, and the amount of overlap of an exhaust valve.
[0011] The 3rd invention prepares a throttle valve in an inlet pipe in the 1st invention, and the aforementioned inhalation air-content presumption means has an amendment amendment means for the estimate of an inhalation air content according to the opening of the throttle valve.
[0012] For the 4th invention, the aforementioned amendment means is a reduction amendment about the estimate of an inhalation air content, so that the opening of a throttle valve is small in the 3rd invention and inlet-pipe negative pressure is large.
[0013] In the 1st invention, the 5th invention judges the amount sensor of inhalation of air to be failure, when the aforementioned failure judging means has the difference of the estimate of the inhalation air content of the aforementioned inhalation air-content presumption means, and the measurement value of the amount sensor of inhalation of air larger than the predetermined failure-criteria value defined beforehand.
[0014] The 6th invention is set up in the failure criteria by the aforementioned failure judging means in the 1st invention for every service condition of the engine which contains an engine speed at least.
[0015] In the 7th invention, in the 1st invention, the aforementioned inhalation air-content presumption means distinguishes ** and the opening-and-closing stage of an exhaust valve from ** and the opening-and-closing control stage of an exhaust valve.
[0016] In the 1st invention, invention of the octavus is equipped with the taking-a-seat sensor which detects ** and the opening-and-closing stage of an exhaust valve, and presumes an inhalation air content actual based on the detection value of ** and the opening-and-closing stage of an exhaust valve for the aforementioned inhalation air-content presumption means to be based on a taking-a-seat sensor.
[0017] The 9th invention is equipped with the display which displays failure of the amount sensor of inhalation of air in the 1st invention.
[0018]
[Effect of the Invention] According to the 1st and the 7th invention, failure of an open circuit of the abnormalities by gap of the output of the amount sensor of inhalation of air and a sensor circuit etc. is easily detectable with a sufficient precision.
[0019] According to the 2nd invention, an accurate presumed inhalation air content can be acquired to change by the closed stage of an exhaust valve, the open stage of an inlet valve, **, and the amount of overlap of an exhaust valve, and fault detection of the amount sensor of inhalation of air can be performed exactly.
[0020] According to the 3rd and the 4th invention, when a throttle valve is prepared, an accurate presumed inhalation air content can be acquired, and it can respond.
[0021] According to the 5th and the 6th invention, the failure judging of the amount sensor of inhalation of air can be performed with a sufficient precision.
[0022] According to invention of the octavus, while failure of ** and an exhaust valve is exactly detectable, the failure judging of the amount sensor of inhalation of air is cancellable at the time of these failures.
[0023] According to the 9th invention, early repair of failure is attained.
[0024]
[Embodiments of the Invention] Hereafter, the gestalt of operation of this invention is explained based on a drawing.
[0025] it is shown in drawing 1 -- as -- 1 -- an engine and 2 -- a cylinder (combustion chamber) and 3 -- for an inlet pipe and 6, as for an ignition plug and 8, an exhaust pipe and 7 are [an inlet valve and 4 / an exhaust valve and 5 / a fuel injection valve and 9] the catalysts for exhaust air purification
[0026] the electromagnetism which drives an inlet valve 3 and an exhaust valve 4 -- two springs 13 and 14 with which actuators 10 and 11 energize moving part 12 in the valve-opening direction and the valve-closing direction like drawing 2 , and two electromagnets 15 and 16 with which moving part 12 is attracted in the valve-opening direction and the valve-closing direction are formed

[0027] the drive circuit 17 -- the electromagnetism of the electromagnet 15 by the side of [the state of drawing 2 to] valve opening -- according to the spring force of the spring 14 by the side of valve closing, while moving part 12 passes through a center valve position and approaches the electromagnet 16 by the side of valve closing, if the current of a coil is intercepted under the present circumstances, the electromagnetism of the electromagnet 16 by the side of valve closing -- energizing in a coil -- the electromagnetism -- moving part 12 overcomes the spring force of the spring 13 by the side of valve opening with a suction force, and the valve is drawn in and closed by the electromagnet 16 by the side of valve closing next, the electromagnetism of the electromagnet 16 by the side of [this state to] valve closing -- shortly according to the spring force of the spring 13 by the side of valve opening, while moving part 12 passes through a center valve position and approaches the electromagnet 15 by the side of valve opening, if the current of a coil is intercepted under the present circumstances, the electromagnetism of the electromagnet 15 by the side of valve opening -- energizing in a coil -- the electromagnetism -- moving part 12 overcomes the spring force of the spring 14 by the side of valve closing with a suction force, and the electromagnet 15 by the side of valve opening draws in and opens in addition, the electromagnetism of both the electromagnets 15 and 16 -- when current is not flowing in a coil, moving part 12 is held in the center valve position (an inlet valve 3 and an exhaust valve 4 are the state of a half-aperture) which estranged only the position from the adsorption side of both the electromagnets 15 and 16 according to the spring force of both the springs 13 and 14, respectively

[0028] On the other hand, the air flow meter (the amount sensor of inhalation of air) 21 which detects the inhalation air content of an engine as a means to detect the service condition of an engine is formed in the inlet pipe 5 which forms a part of inhalation-of-air path, and the signal is inputted into a control unit 20. Moreover, the intake-air-temperature sensor 25 grade which detects an engine speed, the rotational frequency sensor (crank angle sensor) 22 which detects a crank angle, the accelerator opening sensor 23 which detects accelerator opening, the coolant temperature sensor 24 which detects the cooling water temperature of an engine, and an intake-air temperature as a means to detect the service condition of an engine is prepared, and these signals are also inputted into a control unit 20.

[0029] While ** and the opening-and-closing stage of exhaust valves 3 and 4 are controlled by the control unit 20 through the drive circuit 17 based on these sensor signals, control of the fuel oil consumption of a fuel injection valve 8 etc. and the failure judging of the amount sensor 21 of inhalation of air are performed.

[0030] In this case, the open stage of an inlet valve 3 is controlled by the crank angle (intake-stroke section, compression stroke section) from which the time when an engine speed is higher is controlled at a tooth-lead-angle side, and acquires the inhalation air content of a demand based on accelerator opening, an engine speed, etc. in a closed stage on the basis of for example, an inhalation-of-air top dead center. An inhalation air content is fundamentally controlled by the closed stage of an inlet valve 3.

[0031] The closed control stage (crank angle) of this inlet valve 3 searches the closed control stage map which set up the closed control stage of an inlet valve 3 based on accelerator opening and the engine speed like drawing 3 , and is called for. While the maximum amount of inhalation of air in the full open region of accelerator opening sets up the crank angle included in a cylinder (it suits by experiment etc.), on this closed control stage map, the crank angle is set as a tooth lead angle or the crank angle which carries out the angle of delay and obtains the amount of inhalation of air of a demand to a full open region in the partial load region. In addition, the crank angle with which the maximum amount of inhalation of air in the full open region of accelerator opening goes into a cylinder serves as a piston bottom dead point mostly in an engine low rotation region, and becomes a compression stroke side in a high rotation region.

[0032] The open stage of an exhaust valve 4 is controlled near the piston bottom dead point of the between an expansion stroke and like an exhaust air line, and a closed stage is controlled according to an engine speed near an inhalation-of-air top dead center.

[0033] Although not illustrated, the closed control stage (crank angle) of this exhaust valve 4 searches the closed control stage map which set up the closed control stage of an exhaust valve 4 based on accelerator opening and the engine speed, and is called for.

[0034] Moreover, like general fuel-oil-consumption control, the fuel oil consumption of a fuel injection valve 8 performs various amendments, is determined, and is controlled by the inhalation air content which the amount sensor 21 of inhalation of air detected (measurement), and the fundamental injection quantity based on an engine speed.

[0035] In addition, 26 in drawing is the display which displays failure of the amount sensor 21 of inhalation of air, and is prepared in an operation panel etc.

[0036] Next, the failure judging of the amount sensor 21 of inhalation of air is explained based on the flow chart of drawing 4 and drawing 5 .

[0037] As shown in drawing 4 , at Step 1, the cylinder content volume V of the closed stage of an inlet valve 3 is computed. This is computed from the crank angle at the time of closed control of an inlet valve 3, i.e., the position of a piston.

[0038] Here, when distance:x of piston, connecting rod wheel base:h, and crank throw:r, it is x=r(1-COStheta) +lambdar [1-(1-SINtheta2/lambda2) 1 / 2] at the time of the displacement angle theta from a top dead center (crank angle). In lambda=h/r, in simple, it is set to x**r(1-COStheta)+r (1-COS2theta) / 4lambda, and the cylinder content volume V can be found from V=Vcc+Vcyl=Vcc+x-S however Vcc:volume of combustion chamber, and Vcyl:cylinder-capacity S:cylinder cross-section =pi(boa/2) 2.

[0039] Specifically, it computes based on such a formula using the map which set up the cylinder content volume V about crank angle theta.

[0040] At Step 2, the inhalation air content (the amount of new temperaments) of a cylinder 2 is presumed based on the cylinder content volume V. This is performed according to the flow of drawing 5 .

[0041] The flow of drawing 5 starts processing of Step 12 to the steps 13-16, when an exhaust valve 4 closes the valve before valve closing of an inlet valve 3.

[0042] At Step 13, the crank angle of the closed stage of an exhaust valve 4 is read, and the cylinder rest of volume V0 is computed from the crank angle at Step 14. If the closed stage of an exhaust valve 4 is an inhalation-of-air top dead center, the cylinder rest of volume V0 will turn into volume of combustion chamber, and from an inhalation-of-air top dead center, if it is an angle-of-delay side, the cylinder rest of volume V0 will be computed by adding the capacity computed from the crank angle of a closed stage to volume of combustion chamber.

[0043] This cylinder rest of volume V0 is also computed using the map which set up the cylinder content volume V about above-mentioned crank angle theta.

[0044] Exhaust gas pressure is computed at Step 15, and the ** gas mass of a cylinder 2 is computed at Step 16 from the cylinder rest of volume V0, exhaust gas pressure, and an exhaust-gas temperature. It asks for exhaust gas pressure and an exhaust-gas temperature based on an engine speed, accelerator opening, cooling water temperature, etc. using the exhaust-gas-pressure map and exhaust-gas-temperature map which defined exhaust-gas-pressure data and exhaust-gas-temperature data like drawing 6 and drawing 7 by experiment etc., respectively.

[0045] ** gas mass of a cylinder: Ask for G from gaseous equation of state G=process variable/radiographic.

[0046] However, P:exhaust gas pressure, V:cylinder rest of volume, the constant (fixed value) of R:gas-constant = combustion gas, T: Whenever [exhaust gas temperature], after valve closing of this exhaust valve 4, when an inlet valve 3 closes the valve, go into Steps 17-20 from Step 11.

[0047] The new temper capacity in a cylinder is computed at Step 17. This new temper capacity in a cylinder deducts and asks for a part for the ** gas computed at Step 16 from the cylinder content volume V computed at Step 1 of drawing 4 .

[0048] In this case, if the state at the time of a pressure P0, capacity V0, temperature T0, and inlet-valve open is made into a pressure P1, capacity V1, and temperature T1, the state of the combustion gas of an exhaust air valve-closing time Since it is P1V1/T1=P0V0/T0=GR, (however, P's1 being influenced by inlet-pipe negative pressure) and a basic target are asked for V1=(P0/P1) (T1/T0) V0, and this V1 is considered as a part for ** gas, and it deducts from the cylinder content volume V, and asks for the new temper capacity in a cylinder.

[0049] An intake-air temperature is measured at Step 18, and an intake pressure (inlet-pipe negative pressure) is measured at Step 19. Since an intake pressure changes with the opening of a throttle valve when a throttle valve is prepared, in order to obtain inlet-pipe negative pressure to an inlet pipe 5, it detects an intake pressure. The method of detection may refer to a map like drawing 8 for which it asked by experiment etc. beforehand from throttle valve opening as the engine speed, and may form and measure an intake-pressure sensor. However, when an intake pressure is detected, an intake pressure may amend the new temper capacity in a cylinder of Step 17.

[0050] At Step 20, the amount of new temperaments in a presumed cylinder is computed from the new temper capacity in a cylinder, intake-air temperature and atmospheric pressure, or an intake pressure. It is a reduction amendment about the amount of new temperaments in a presumed cylinder, so that inlet-pipe negative pressure is large, when a throttle valve is prepared.

[0051] In this case, since the amount of new temperaments in a cylinder changes according to an engine speed, the closed stage of an exhaust valve 4, the open stage of an inlet valve 3, **, and the amount of overlap of exhaust valves 3 and 4 like drawing 9 - drawing 11 , it amends the amount of new temperaments in a presumed cylinder according to these engine speeds, the closed stage of an exhaust valve 4, the open stage of an inlet valve 3, **, and the amount of overlap of exhaust valves 3 and 4. Correction value is calculated from the map which set correction value as the property as shown in drawing 11 to the amount of overlap from the map set as the property that correction value is shown in drawing 10 to the open stage of an inlet valve 3 from the map set as the property as shown in drawing 9 to the closed stage of an exhaust valve 4 when there was overlap of ** and exhaust valves 3 and 4, and multiplication is carried out to the amount of new temperaments in a presumed cylinder. In addition, drawing 10 is the case where the open stage of an inlet valve 3 is in an angle-of-delay side from an inhalation-of-air top dead center.

[0052] Next, at Step 3 of drawing 4 , it reads, the measurement value (after temperature compensation and pressure correction), i.e., the inhalation-of-air mass, of the amount sensor (AFM) 21 of inhalation of air, and Step 4 performs the failure judging of the amount sensor 21 of inhalation of air for the inhalation-of-air mass as compared with the amount of new temperaments in a presumed cylinder.
[0053] The failure judging of this amount sensor 21 of inhalation of air judges with failure, when the difference of inhalation-of-air mass and the amount of new temperaments in a presumed cylinder is larger than the specified quantity (criterion value) defined beforehand.
[0054] The example of the failure criteria based on an engine speed is shown in drawing 12 . An engine speed is low, and when the difference is large, the time of being easy to inhale inhalation of air in a cylinder 2 has set up the criterion so that it may judge with failure, so that an engine speed judges with failure above a difference with the comparatively small difference of inhalation-of-air mass and the amount of new temperaments in a presumed cylinder at the time of a low and an engine speed becomes high, since the exact amount of new temperaments in a presumed cylinder is obtained.
[0055] Moreover, based on an engine speed and accelerator opening, failure criteria can also be set up like drawing 13 . In this case, since variation appears in the amount of new temperaments in a presumed cylinder according to the operation delay of opening and closing of inlet-valve 3 grade etc., accelerator opening is small and, in the time when the open period of an inlet valve 3 is smaller, a relative error becomes large. Therefore, accelerator opening is large, an engine speed judges with failure above a difference with the comparatively small difference of inhalation-of-air mass and the amount of new temperaments in a presumed cylinder at the time of a low, accelerator opening is small, and when the difference is large, a criterion is set up so that it may judge with failure, so that an engine speed becomes high.
[0056] And when it judges with failure, failure of the amount sensor 21 of inhalation of air is displayed with the display 26 prepared in the operation panel etc.
[0057] Thus, since the actual inhalation air content of a cylinder 2 is presumed and failure of the amount sensor 21 of inhalation of air is judged based on the estimate, failure of an open circuit of the abnormalities by gap of the output of the amount sensor 21 of inhalation of air and a sensor circuit etc. is easily detectable with a sufficient precision.
[0058] in this case -- while presuming the inhalation air content of a cylinder 2 based on the cylinder content volume of the closed stage of an inlet valve 3 -- this -- the closed stage of an exhaust valve 4, the open stage of an inlet valve 3, **, and the amount of overlap of exhaust valves 3 and 4 -- responding -- an amendment -- an accurate presumed inhalation air content can be acquired by things
[0059] Moreover, since it is got blocked, and it judges with failure above a difference with the comparatively small difference of the measurement value of the amount sensor 21 of inhalation of air, and a presumed inhalation air content when [when the precision of a presumed inhalation air content is high] engine speeds are low conditions while setting up the criterion of failure for every service condition of the engine containing an engine speed, a failure judging can be performed with a sufficient precision.
[0060] Therefore, fault detection of the amount sensor 21 of inhalation of air can be performed exactly. Moreover, since an operator is told with display 26 at the time of failure, it can repair at an early stage.
[0061] On the other hand, although the inhalation air content of a cylinder 2 is controlled by the closed stage of an inlet valve 3 etc., since this engine adds amendment, i.e., inlet-pipe negative pressure, for an inhalation air content according to the opening and presumes an inhalation air content when a throttle valve is prepared, in order to obtain inlet-pipe negative pressure to an inlet pipe 5, when a throttle valve is prepared, it can respond.
[0062] Moreover, in this example, although these opening-and-closing stages are judged by ** by the control unit 20, the open control stage of exhaust valves 3 and 4, and the closed control stage, as shown in drawing 1 , the taking-a-seat sensors 30 and 31 which detect ** and the valve-closing state of exhaust valves 3 and 4 are formed, and the taking-a-seat sensors 30 and 31 can detect ** and the opening-and-closing stage of exhaust valves 3 and 4. as these taking-a-seat sensors 30 and 31, a gap sensor, a non-contact position sensor, etc. use, for example -- having -- the electromagnetism of ** and exhaust valves 3 and 4 -- it is installed in an actuator 10 and 11 grades If it does in this way, while failure of a valve is detectable, the failure judging of the amount sensor 21 of inhalation of air is cancellable at the time of valve failure. Moreover, the variation in the presumed inhalation air content by the operation delay of opening and closing of inlet-valve 3 grade etc. can be reduced.
[0063] in addition, this example -- electromagnetism -- although this invention is applied to the good change valve of a drive formula, it is also applicable to the good change valve engine which drives ** and an exhaust valve with oil pressure

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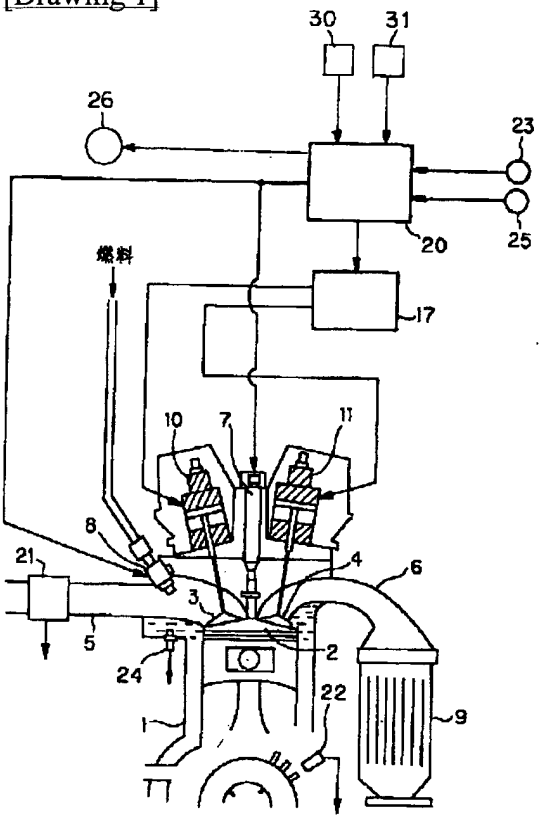
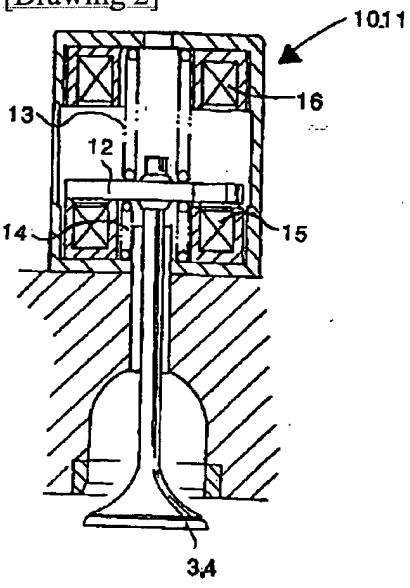
DRAWINGS

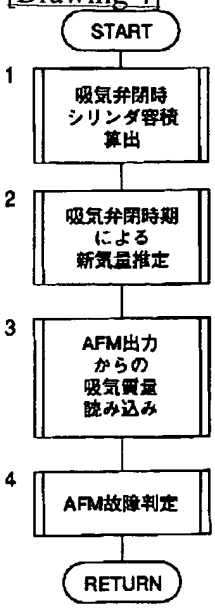
[Drawing 1]



[Drawing 2]



[Drawing 4]



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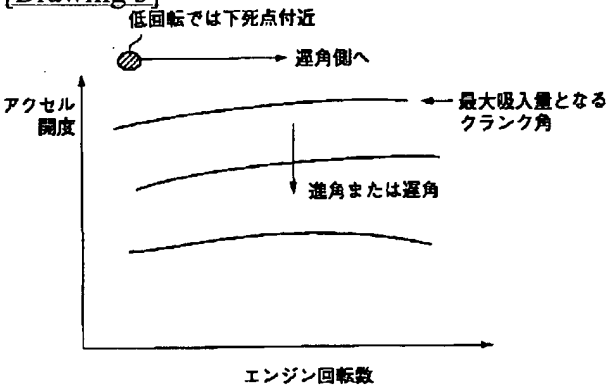
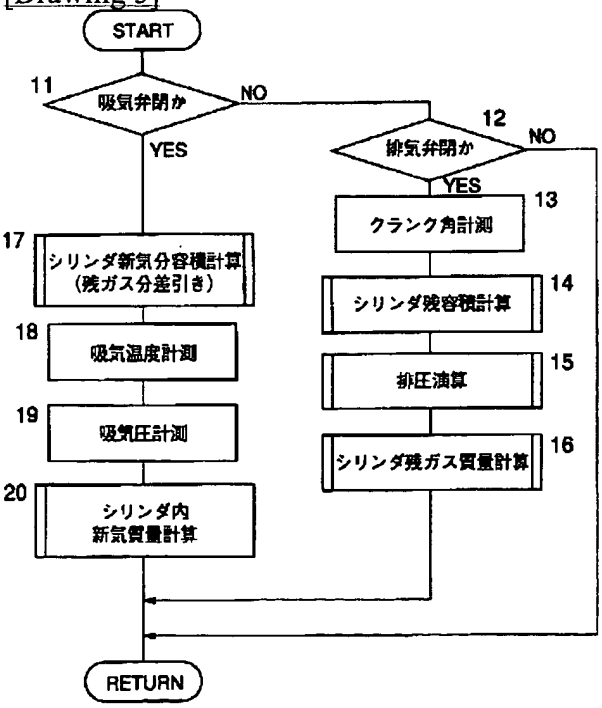
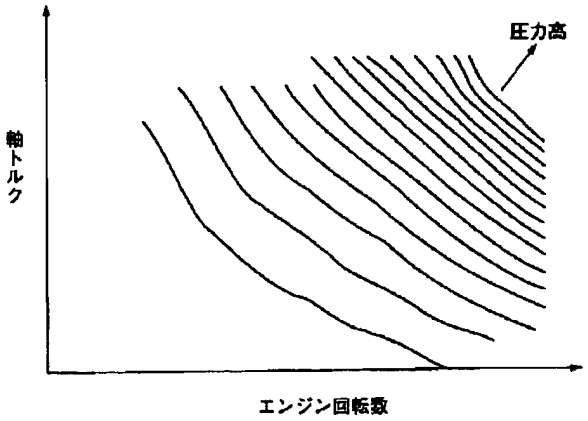


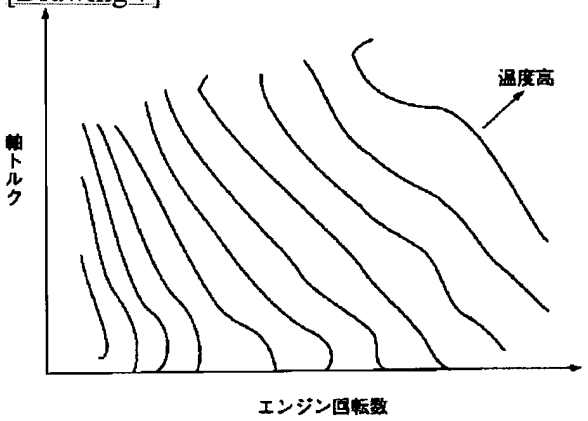
[Drawing 5]



[Drawing 6]



[Drawing 7]



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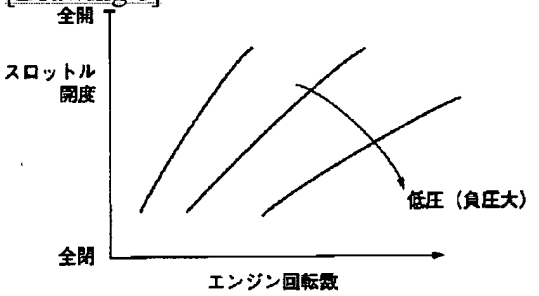

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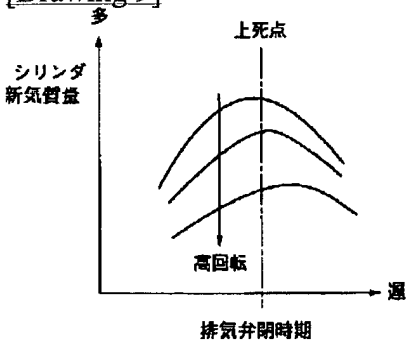

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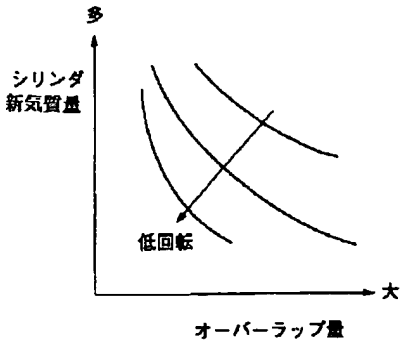

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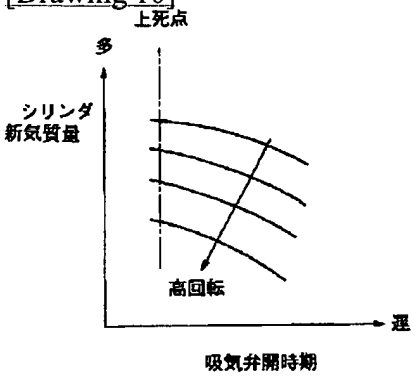

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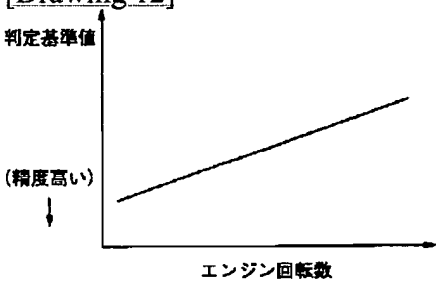

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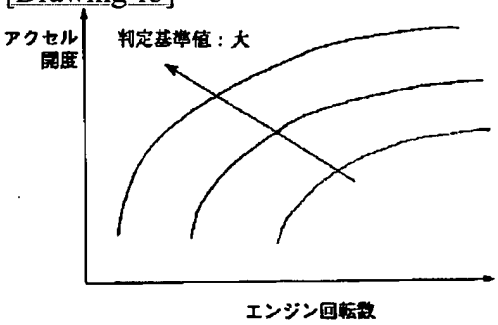


[Translation done.]

(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2000－161124
（P2000－161124A）
(43)公開日　平成12年６月13日(2000.6.13)

(51)Int.Cl.⁷	識別記号	ＦＩ		テーマコード（参考）
Ｆ０２Ｄ　45/00	３６６	Ｆ０２Ｄ　45/00	３６６Ｈ	３Ｇ０８４
Ｆ０１Ｌ　3/24		Ｆ０１Ｌ　3/24	Ｂ	３Ｇ０９２
Ｆ０２Ｄ　13/02		Ｆ０２Ｄ　13/02	Ｇ	

審査請求　未請求　請求項の数９　ＯＬ　（全　８　頁）

(21)出願番号　特願平10－334298

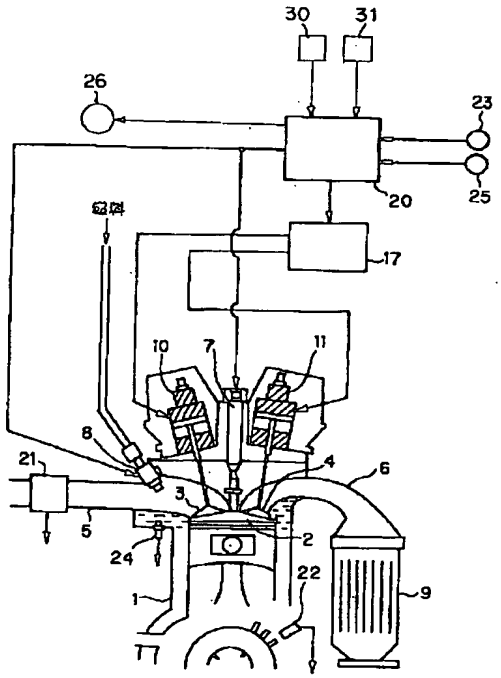
(22)出願日　平成10年11月25日(1998.11.25)

(71)出願人　000003997
日産自動車株式会社
神奈川県横浜市神奈川区宝町２番地
(72)発明者　松本　幹雄
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内
(72)発明者　永石　初雄
神奈川県横浜市神奈川区宝町２番地　日産自動車株式会社内
(74)代理人　100075513
弁理士　後藤　政喜　（外１名）

最終頁に続く

(54)【発明の名称】　可変動弁エンジンの故障検出装置

(57)【要約】
【課題】　吸、排気弁を備える可変動弁エンジンの吸気量センサの故障を的確に検出する。
【解決手段】　吸、排気弁３，４を備え、これらの弁の開閉時期によってシリンダの吸入空気量および排気ガスの排出を制御する一方、吸気通路５に吸入空気量を計測する吸気量センサ２１を備える可変動弁エンジンにおいて、少なくとも吸気弁３の閉時期のシリンダ内容積を基に実際の吸入空気量を推定する吸入空気量推定手段と、この推定値と吸気量センサ２１の計測値を比較する比較手段と、この比較結果を基に吸気量センサ２１の故障判定を行う故障判定手段とを設ける。



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【特許請求の範囲】

【請求項１】　吸、排気弁を備え、これらの弁の開閉時期によってシリンダの吸入空気量および排気ガスの排出を制御する一方、吸気通路に吸入空気量を計測する吸気量センサを備える可変動弁エンジンにおいて、
少なくとも吸気弁の閉時期のシリンダ内容積を基に実際の吸入空気量を推定する吸入空気量推定手段と、
この推定値と吸気量センサの計測値を比較する比較手段と、
この比較結果を基に吸気量センサの故障判定を行う故障判定手段とを設けたことを特徴とする可変動弁エンジンの故障検出装置。

【請求項２】　前記吸入空気量推定手段は、吸入空気量の推定値を、排気弁の閉時期もしくは吸気弁の開時期もしくは吸、排気弁のオーバーラップ量に応じて補正する補正手段を持つ請求項１に記載の可変動弁エンジンの故障検出装置。

【請求項３】　吸気管に絞り弁を設け、前記吸入空気量推定手段は、吸入空気量の推定値を、その絞り弁の開度に応じて補正する補正手段を持つ請求項１に記載の可変動弁エンジンの故障検出装置。

【請求項４】　前記補正手段は、絞り弁の開度が小さく吸気管負圧が大きいほど、吸入空気量の推定値を減少補正する請求項３に記載の可変動弁エンジンの故障検出装置。

【請求項５】　前記故障判定手段は、前記吸入空気量推定手段の吸入空気量の推定値と吸気量センサの計測値との差が、予め定めた所定の故障判定基準値よりも大きいときに、吸気量センサを故障と判定する請求項１に記載の可変動弁エンジンの故障検出装置。

【請求項６】　前記故障判定手段による故障判定基準を、少なくともエンジン回転数を含むエンジンの運転条件毎に設定してある請求項１に記載の可変動弁エンジンの故障検出装置。

【請求項７】　前記吸入空気量推定手段は、吸、排気弁の開閉制御時期より吸、排気弁の開閉時期を判別する請求項１に記載の可変動弁エンジンの故障検出装置。

【請求項８】　吸、排気弁の開閉時期を検出する着座センサを備え、前記吸入空気量推定手段は、着座センサによるに吸、排気弁の開閉時期の検出値を基に実際の吸入空気量を推定する請求項１に記載の可変動弁エンジンの故障検出装置。

【請求項９】　吸気量センサの故障を表示する表示装置を備える請求項１に記載の可変動弁エンジンの故障検出装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、吸、排気弁を備える可変動弁エンジンの故障検出装置に関し、特に吸入空気量を計測する吸気量センサの故障を検出する装置に関する。

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【０００２】

【従来の技術】エンジンの吸、排気弁をカム駆動に変えて電磁力で駆動するものがある。このものは、カムシャフト等の機構を省略することができ、エンジンの運転状態に合った弁開閉タイミングに設定できると共に、弁開閉タイミングによって、シリンダの吸入空気量および排気ガスの排出を制御することが可能である（特開昭６１－２４７８０７号公報等）。

【０００３】また、油圧により吸、排気弁を駆動するものがある（特開平７－３１７５１６号公報等）。これは、オイルポンプにより昇圧されたオイルを、吸気弁や排気弁を駆動するピストンとこのピストンが摺動するシリンダとにより画成された油圧室に、オイルの供給と遮断を行う気筒毎に設定された電磁式スピル弁を介して供給することで、気筒毎に吸気弁や排気弁を所望の開弁時期、閉弁時期に制御するものである。

【０００４】このようなエンジンにおけるエンジン吸気量の計測方法として、絞り弁上流の吸気通路にエアフローメータ（吸気量センサ）を備え、吸気量センサが計測した吸入空気量とエンジン回転数から燃料の基本的な噴射量を求め、これを基に種々の補正を行って燃料噴射弁の燃料噴射量を制御するものにおいては、この吸気量センサに異常があると、例えば燃料噴射量を適正に制御できなくなる。

【０００５】従来、このような吸気量センサの故障検出装置として、センサ回路の断線の有無を検出するもの（特開平１０－６８６４７号公報）、排気系に設けた酸素濃度センサの信号から吸気量センサの故障を間接的に判定するもの、あるいは吸気量センサの信号波形つまり吸気弁の開閉に伴う吸気脈動によって生じる信号の最大出力値と最小出力値との偏差から吸気量センサの故障を判定するもの（特開平５－００１９３０号公報）等がある。

【０００６】

【発明が解決しようとする課題】しかしながら、センサ回路の断線の有無を検出するものは、吸気量センサの出力のズレによる異常は検出できず、酸素濃度センサの信号から吸気量センサの故障を判定するものは、燃料系の故障との区別をつけにくい。

【０００７】また、吸気量センサの最大出力値と最小出力値との偏差から吸気量センサの故障を判定するものは、吸気通路に設けた絞り弁よりも吸、排気弁によってシリンダの吸入空気量等を制御する場合、吸気弁の開閉タイミングによって吸気脈動が変わるため、必ずしも適用しにくいのである。

【０００８】この発明は、吸、排気弁の開閉タイミングによってシリンダの吸入空気量等を制御する可変動弁エンジンの場合、その開閉タイミングによってシリンダの吸入空気量を推定可能なことに着目し、その推定値と吸

気量センサの計測値との比較によって吸気量センサの故障を的確に検出できる故障検出装置を提供することを目的としている。

【０００９】

【課題を解決するための手段】第１の発明は、吸、排気弁を備え、これらの弁の開閉時期によってシリンダの吸入空気量および排気ガスの排出を制御する一方、吸気通路に吸入空気量を計測する吸気量センサを備える可変動弁エンジンにおいて、少なくとも吸気弁の閉時期のシリンダ内容積を基に実際の吸入空気量を推定する吸入空気量推定手段と、この推定値と吸気量センサの計測値を比較する比較手段と、この比較結果を基に吸気量センサの故障判定を行う故障判定手段とを設ける。

【００１０】第２の発明は、第１の発明において、前記吸入空気量推定手段は、吸入空気量の推定値を、排気弁の閉時期もしくは吸気弁の開時期もしくは吸、排気弁のオーバーラップ量に応じて補正する補正手段を持つ。

【００１１】第３の発明は、第１の発明において、吸気管に絞り弁を設け、前記吸入空気量推定手段は、吸入空気量の推定値を、その絞り弁の開度に応じて補正する補正手段を持つ。

【００１２】第４の発明は、第３の発明において、前記補正手段は、絞り弁の開度が小さく吸気管負圧が大きいほど、吸入空気量の推定値を減少補正する。

【００１３】第５の発明は、第１の発明において、前記故障判定手段は、前記吸入空気量推定手段の吸入空気量の推定値と吸気量センサの計測値との差が、予め定めた所定の故障判定基準値よりも大きいときに、吸気量センサを故障と判定する。

【００１４】第６の発明は、第１の発明において、前記故障判定手段による故障判定基準を、少なくともエンジン回転数を含むエンジンの運転条件毎に設定してある。

【００１５】第７の発明は、第１の発明において、前記吸入空気量推定手段は、吸、排気弁の開閉制御時期より吸、排気弁の開閉時期を判別する。

【００１６】第８の発明は、第１の発明において、吸、排気弁の開閉時期を検出する着座センサを備え、前記吸入空気量推定手段は、着座センサによるに吸、排気弁の開閉時期の検出値を基に実際の吸入空気量を推定する。

【００１７】第９の発明は、第１の発明において、吸気量センサの故障を表示する表示装置を備える。

【００１８】

【発明の効果】第１、第７の発明によれば、吸気量センサの出力のズレによる異常、センサ回路の断線等の故障を容易に精度良く検出できる。

【００１９】第２の発明によれば、排気弁の閉時期、吸気弁の開時期、吸、排気弁のオーバーラップ量による変化に対して精度良い推定吸入空気量を得ることができ、吸気量センサの故障検出を的確に行える。

【００２０】第３、第４の発明によれば、絞り弁を設け

た場合にも精度良い推定吸入空気量を得ることができ、対応できる。

【００２１】第５、第６の発明によれば、吸気量センサの故障判定を精度良く行える。

【００２２】第８の発明によれば、吸、排気弁の故障を的確に検出できると共に、これらの故障時に吸気量センサの故障判定をキャンセルできる。

【００２３】第９の発明によれば、故障の早期補修が可能になる。

【００２４】

【発明の実施の形態】以下、本発明の実施の形態を図面に基づいて説明する。

【００２５】図１に示すように、１はエンジン、２はシリンダ（燃焼室）、３は吸気弁、４は排気弁、５は吸気管、６は排気管、７は点火栓、８は燃料噴射弁、９は排気浄化用触媒である。

【００２６】吸気弁３、排気弁４を駆動する電磁アクチュエータ１０，１１は、図２のように可動部１２を開弁方向と閉弁方向に付勢する２つのスプリング１３，１４と、可動部１２を開弁方向と閉弁方向に吸引する２つの電磁石１５，１６とが設けられる。

【００２７】駆動回路１７によって、図２の状態から開弁側の電磁石１５の電磁コイルの電流が遮断されると、閉弁側のスプリング１４のバネ力により、可動部１２は中立位置を通過して閉弁側の電磁石１６に接近すると共に、この際閉弁側の電磁石１６の電磁コイルに通電しておくことで、その電磁吸引力により可動部１２は開弁側のスプリング１３のバネ力に打ち勝って閉弁側の電磁石１６に吸引され、閉弁される。次に、この状態から閉弁側の電磁石１６の電磁コイルの電流が遮断されると、今度は開弁側のスプリング１３のバネ力により、可動部１２は中立位置を通過して開弁側の電磁石１５に接近すると共に、この際開弁側の電磁石１５の電磁コイルに通電しておくことで、その電磁吸引力により可動部１２は閉弁側のスプリング１４のバネ力に打ち勝って開弁側の電磁石１５に吸引され、開弁される。なお、両電磁石１５，１６の電磁コイルに電流が流れていない場合には、可動部１２は両スプリング１３，１４のバネ力により両電磁石１５，１６の吸着面からそれぞれ所定の位置だけ離間した中立位置（吸気弁３、排気弁４が半開きの状態）に保持される。

【００２８】一方、吸気通路の一部を形成する吸気管５には、エンジンの運転条件を検出する手段として、エンジンの吸入空気量を検出するエアフローメータ（吸気量センサ）２１が設けられ、その信号はコントロールユニット２０に入力される。また、エンジンの運転条件を検出する手段として、エンジン回転数、クランク角を検出する回転数センサ（クランク角センサ）２２、アクセル開度を検出するアクセル開度センサ２３、エンジンの冷却水温を検出する水温センサ２４および吸気温度を検出

する吸気温度センサ２５等が設けられ、これらの信号もコントロールユニット２０に入力される。

【００２９】これらのセンサ信号に基づいて、コントロールユニット２０によって、吸、排気弁３，４の開閉時期が駆動回路１７を介して制御されると共に、燃料噴射弁８の燃料噴射量等の制御、吸気量センサ２１の故障判定が行われる。

【００３０】この場合、吸気弁３の開時期は例えば吸気上死点を基準にエンジン回転数が高いときほど進角側に制御され、閉時期はアクセル開度、エンジン回転数等に基づく要求の吸入空気量を得るクランク角（吸気行程区間、圧縮行程区間）に制御される。基本的に吸気弁３の閉時期によって吸入空気量が制御される。

【００３１】この吸気弁３の閉制御時期（クランク角）は、例えば図３のようにアクセル開度とエンジン回転数を基に吸気弁３の閉制御時期を設定した閉制御時期マップを検索して求められる。この閉制御時期マップでは、アクセル開度の全開域において最大の吸気量がシリンダに入るクランク角を設定（実験等により適合）すると共に、部分負荷域では全開域に対してクランク角を進角または遅角して要求の吸気量を得るクランク角に設定している。なお、アクセル開度の全開域において最大の吸気量がシリンダに入るクランク角は、エンジン低回転域ではほぼピストン下死点となり、高回転域では圧縮行程側となる。

【００３２】排気弁４の開時期は膨張行程と排気行程の間のピストン下死点付近に制御され、閉時期は吸気上死点付近にエンジン回転数に応じて制御される。

【００３３】この排気弁４の閉制御時期（クランク角）は、図示しないがアクセル開度とエンジン回転数を基に排気弁４の閉制御時期を設定した閉制御時期マップを検索して求められる。

【００３４】また、燃料噴射弁８の燃料噴射量は、一般的な燃料噴射量制御と同様に、吸気量センサ２１が検出（計測）した吸入空気量とエンジン回転数に基づく基本的な噴射量に種々の補正を行って決定され、制御される。

【００３５】なお、図中２６は吸気量センサ２１の故障を表示する表示装置で、運転パネル等に設けられる。

【００３６】次に、吸気量センサ２１の故障判定を、図４、図５のフローチャートに基づいて説明する。

【００３７】図４に示すように、ステップ１では、吸気弁３の閉時期のシリンダ内容積Ｖを算出する。これは、吸気弁３の閉制御時のクランク角つまりピストンの位置から算出する。

【００３８】ここで、ピストンの行程：ｘ、コンロッド軸間距離：ｈ、クランク半径：ｒとすると、上死点からの変位角θ（クランク角）のとき、

$x = r(1-\cos\theta) + \lambda r[1-(1-\sin^2\theta/\lambda^2)^{1/2}]$

$\lambda = h/r$

で、簡略的には、

$x \fallingdotseq r(1-\cos\theta) + r(1-\cos 2\theta)/4\lambda$

となり、シリンダ内容積Ｖは

$V = Vcc + Vcyl$

$= Vcc + x \cdot S$

ただし、Ｖcc：燃焼室容積、Ｖcyl：行程容積

Ｓ：シリンダ断面積$=\pi$（ボア／２）^{2}

から求まる。

【００３９】具体的には、このような式を基に、クランク角θについてシリンダ内容積Ｖを設定したマップを用いて算出する。

【００４０】ステップ２では、そのシリンダ内容積Ｖを基に、シリンダ２の吸入空気量（新気質量）を推定する。これは、図５のフローにしたがって行う。

【００４１】図５のフローは、吸気弁３の閉弁前に、排気弁４が閉弁したときに、ステップ１２からステップ１３～１６の処理に入る。

【００４２】ステップ１３では、排気弁４の閉時期のクランク角を読み込み、ステップ１４では、そのクランク角からシリンダ残容積V_0を算出する。排気弁４の閉時期が吸気上死点であれば、シリンダ残容積V_0は燃焼室容積となり、吸気上死点より遅角側であれば、燃焼室容積に閉時期のクランク角から算出した容積を加算してシリンダ残容積V_0を算出する。

【００４３】このシリンダ残容積V_0も、前述のクランク角θについてシリンダ内容積Ｖを設定したマップを用いて算出する。

【００４４】ステップ１５では、排圧を算出し、ステップ１６では、シリンダ残容積V_0と排圧と排気温度からシリンダ２の残ガス質量を算出する。排圧および排気温度は、それぞれエンジン回転数、アクセル開度、冷却水温等を基に、実験等により図６、図７のように排圧データ、排気温度データを定めた排圧マップ、排気温度マップを用いて求める。

【００４５】シリンダの残ガス質量：Ｇは、気体の状態方程式Ｇ＝ＰＶ／ＲＴより求める。

【００４６】ただし、Ｐ：排圧、Ｖ：シリンダ残容積、Ｒ：ガス定数＝燃焼ガスの定数（固定値）、Ｔ：排気温度

この排気弁４の閉弁後、吸気弁３が閉弁したときに、ステップ１１からステップ１７～２０に入る。

【００４７】ステップ１７では、シリンダ内新気分容積を算出する。このシリンダ内新気分容積は、図４のステップ１にて算出したシリンダ内容積Ｖからステップ１６にて算出した残ガス分を差し引いて求める。

【００４８】この場合、排気弁閉時の燃焼ガスの状態を圧力P_0、容積V_0、温度T_0、吸気弁開時の状態を圧力P_1、容積V_1、温度T_1とすると（ただし、P_1は吸気管負圧に影響される）、基本的には$P_1V_1/T_1 = P_0V_0$

／T_0＝ＧＲなので、

V_1＝（P_0／P_1）（T_1／T_0）V_0

を求め、このV_1を残ガス分としてシリンダ内容積Ｖから差し引いてシリンダ内新気分容積を求める。

【００４９】ステップ１８では吸気温度を、ステップ１９では吸気圧（吸気管負圧）を計測する。吸気圧は、吸気管５に吸気管負圧を得るために絞り弁を設けた場合、絞り弁の開度によって変化するため、吸気圧の検出を行う。検出の方法は、エンジン回転数と絞り弁開度から予め実験等により求めておいた図８のようなマップを参照しても良いし、吸気圧センサを設けて計測しても良い。ただし、吸気圧を検出した場合、吸気圧によってステップ１７のシリンダ内新気分容積を補正して良い。

【００５０】ステップ２０では、そのシリンダ内新気分容積と吸気温度と大気圧または吸気圧とから、推定シリンダ内新気質量を算出する。絞り弁を設けた場合、吸気管負圧が大きいほど、推定シリンダ内新気質量を減少補正する。

【００５１】この場合、シリンダ内新気質量は、図９～図１１のようにエンジン回転数、排気弁４の閉時期、吸気弁３の開時期、吸、排気弁３，４のオーバーラップ量に応じて変化するため、これらエンジン回転数、排気弁４の閉時期、吸気弁３の開時期、吸、排気弁３，４のオーバーラップ量に応じて、推定シリンダ内新気質量を補正する。排気弁４の閉時期に対しては、図９に示すような特性に設定したマップから補正値を、吸気弁３の開時期に対しては、図１０に示すような特性に設定したマップから補正値を、吸、排気弁３，４のオーバーラップがあるときは、そのオーバーラップ量に対して図１１に示すような特性に設定したマップから補正値を求め、推定シリンダ内新気質量に乗算する。なお、図１０は吸気弁３の開時期が吸気上死点から遅角側にある場合である。

【００５２】次に、図４のステップ３にて、吸気量センサ（ＡＦＭ）２１の計測値つまり吸気質量（温度補正、圧力補正後）を読み込み、ステップ４にてその吸気質量を推定シリンダ内新気質量と比較して、吸気量センサ２１の故障判定を行う。

【００５３】この吸気量センサ２１の故障判定は、吸気質量と推定シリンダ内新気質量との差が予め定められた所定量（判定基準値）より大きいときに故障と判定する。

【００５４】図１２にエンジン回転数に基づく故障判定基準の例を示す。エンジン回転数が低く、シリンダ２に吸気を吸入しやすいときほど、正確な推定シリンダ内新気質量が得られるので、エンジン回転数が低いときは吸気質量と推定シリンダ内新気質量との差が比較的小さい差以上で故障と判定し、エンジン回転数が高くなるほどその差が大きいときに故障と判定するように、判定基準を設定している。

【００５５】また、図１３のようにエンジン回転数とアクセル開度に基づき故障判定基準を設定することもできる。この場合、吸気弁３等の開閉の作動遅れ等により推定シリンダ内新気質量にバラツキが出るので、アクセル開度が小さく、吸気弁３の開期間が小さいときほど誤差率が大きくなる。そのため、アクセル開度が大きく、エンジン回転数が低いときは吸気質量と推定シリンダ内新気質量との差が比較的小さい差以上で故障と判定し、アクセル開度が小さく、エンジン回転数が高くなるほどその差が大きいときに故障と判定するように、判定基準を設定する。

【００５６】そして、故障と判定したときは、運転パネル等に設けた表示装置２６によって吸気量センサ２１の故障を表示する。

【００５７】このように、シリンダ２の実際の吸入空気量を推定し、その推定値を基に吸気量センサ２１の故障を判定するので、吸気量センサ２１の出力のズレによる異常、センサ回路の断線等の故障を容易に精度良く検出できる。

【００５８】この場合、吸気弁３の閉時期のシリンダ内容積を基にシリンダ２の吸入空気量を推定すると共に、これを排気弁４の閉時期、吸気弁３の開時期、吸、排気弁３，４のオーバーラップ量に応じて補正することによって、精度の良い推定吸入空気量を得ることができる。

【００５９】また、故障の判定基準をエンジン回転数を含むエンジンの運転条件毎に設定すると共に、推定吸入空気量の精度が高いつまりエンジン回転数が低い条件のときに吸気量センサ２１の計測値と推定吸入空気量との差が比較的小さい差以上で故障と判定するので、故障判定を精度良く行える。

【００６０】したがって、吸気量センサ２１の故障検出を的確に行える。また、故障時に表示装置２６によって運転者に知らせるので、早期に補修が可能である。

【００６１】一方、本エンジンは、吸気弁３の閉時期等によってシリンダ２の吸入空気量が制御されるが、吸気管５に吸気管負圧を得るために絞り弁を設けた場合、その開度に応じて吸入空気量を補正つまり吸気管負圧を加えて吸入空気量を推定するので、絞り弁を設けた場合にも対応できる。

【００６２】また、本例では、コントロールユニット２０による吸、排気弁３，４の開制御時期、閉制御時期によってこれらの開閉時期を判定しているが、図１に示すように吸、排気弁３，４の閉弁状態を検出する着座センサ３０，３１を設け、着座センサ３０，３１によって吸、排気弁３，４の開閉時期を検出するようにもできる。この着座センサ３０，３１としては、例えばギャップセンサや非接触の位置センサ等が用いられ、吸、排気弁３，４の電磁アクチュエータ１０，１１等に設置される。このようにすれば、弁の故障を検出できると共に、弁故障時に吸気量センサ２１の故障判定をキャンセルできる。また、吸気弁３等の開閉の作動遅れ等による推定

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吸入空気量のバラツキを低減できる。

【００６３】なお、本例は、電磁駆動式の可変動弁に本発明を適用したものであるが、油圧により吸、排気弁を駆動する可変動弁エンジンに適用することもできる。

【図面の簡単な説明】

【図１】第１の実施の形態を示す構成断面図である。

【図２】電磁駆動式の吸、排気弁の構成図である。

【図３】吸気弁の閉制御時期マップの例の特性図である。

【図４】制御内容を示すフローチャートである。

【図５】制御内容を示すフローチャートである。

【図６】排圧マップの例の特性図である。

【図７】排気温度マップの例の特性図である。

【図８】吸気圧マップの例の特性図である。

【図９】排気弁閉時期に対する吸入空気量の特性図である。

【図１０】吸気弁開時期に対する吸入空気量の特性図である。

【図１１】バルブオーバーラップ量に対する吸入空気量の特性図である。

【図１２】エンジン回転数に対する判定基準の例を示す*

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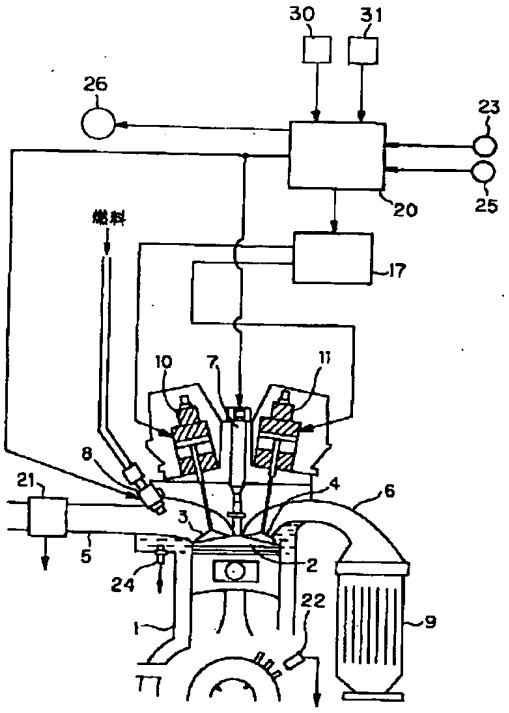
*特性図である。

【図１３】エンジン回転数とアクセル開度に対する判定基準の例を示す特性図である。

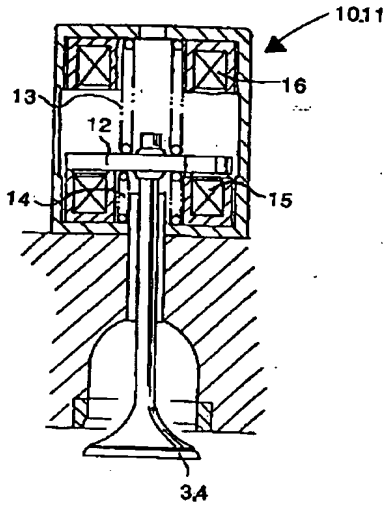
【符号の説明】

２　シリンダ
３　吸気弁
４　排気弁
５　吸気管
６　排気管
８　燃料噴射弁
１０，１１　電磁アクチュエータ
１７　駆動回路
２０　コントロールユニット
２１　吸気量センサ
２２　回転数センサ（クランク角センサ）
２３　アクセル開度センサ
２４　水温センサ
２５　吸気温度センサ
２６　表示装置
３０，３１　着座センサ

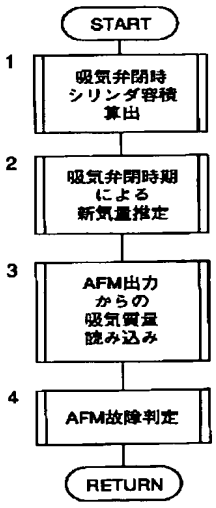
【図１】



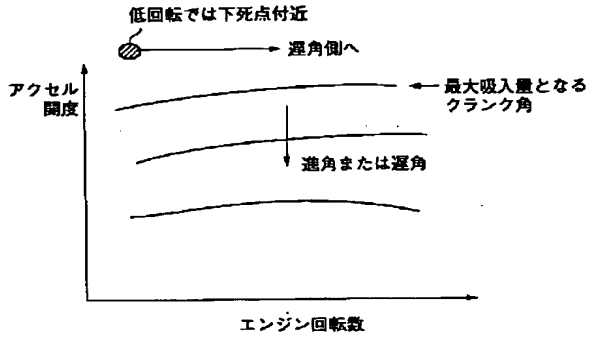
【図２】



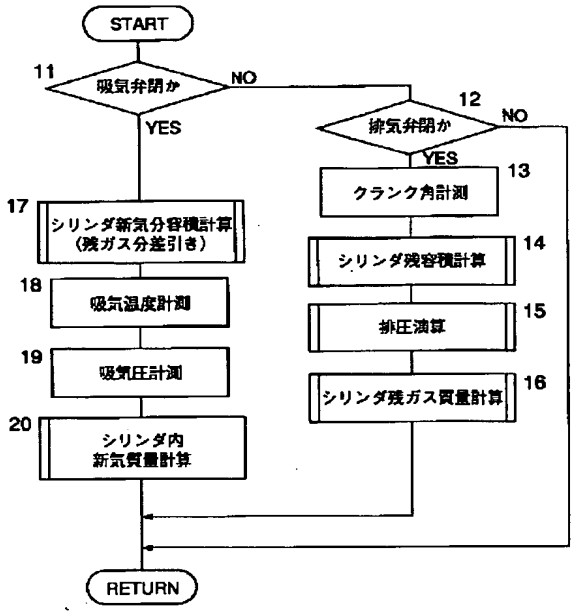
【図４】



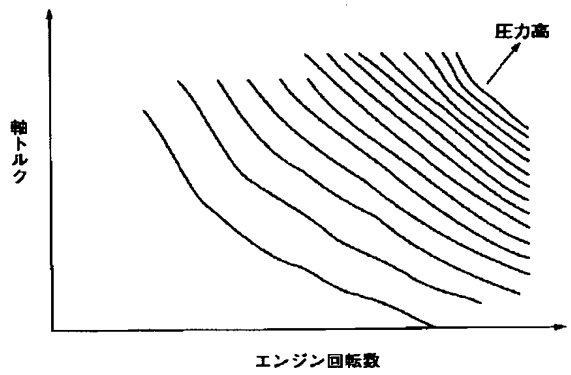
【図３】



【図５】



【図６】



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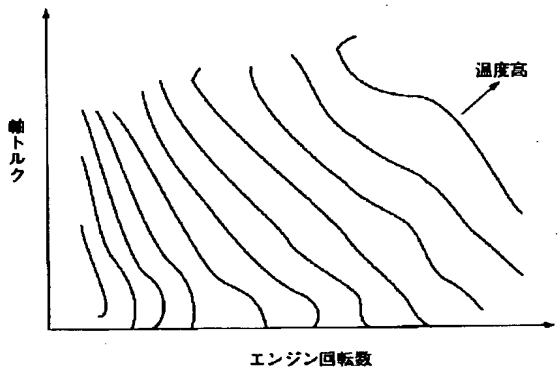
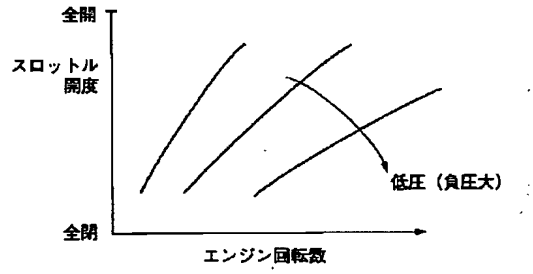
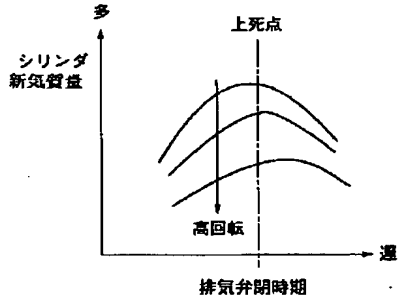


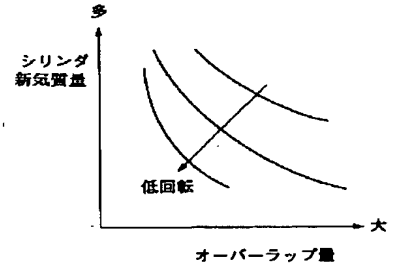
【図８】



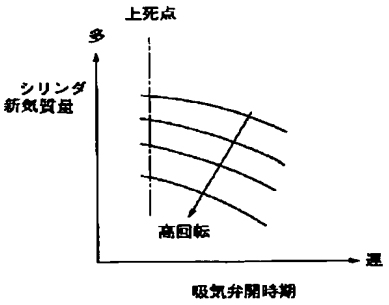
【図９】



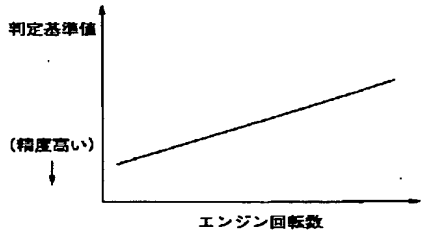
【図１１】



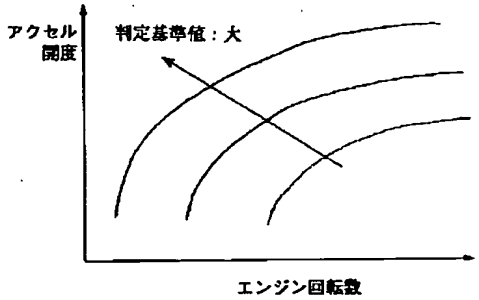
【図１０】



【図１２】



【図１３】



フロントページの続き

(72)発明者　平澤　崇彦
神奈川県横浜市神奈川区宝町２番地　日産
自動車株式会社内

Ｆターム(参考)　3G084 BA23 BA33 DA27 DA30 EA11
EB09 EB12 EB22 FA00 FA02
FA07 FA10 FA11 FA33
3G092 AA11 DA07 EA10 EC01 EC10
FB02 FB06 HA01Z HA04Z
HA05Z HA06Z HA13Z HE01Z